Plans/Results for TES/AIRS/MOPITT CO Validations

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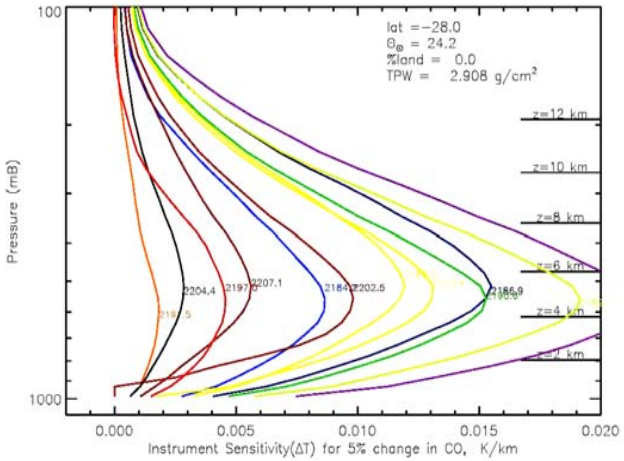
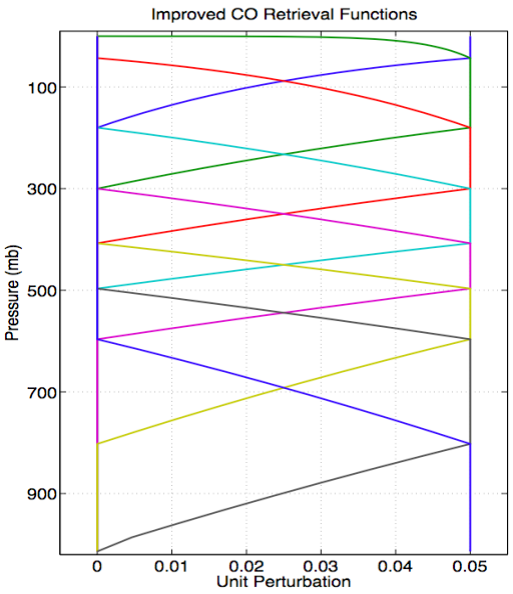
- AURA validation funding started June 1, 2006
- Background on AIRS CO
- Inter-comparison of AIRS and MOPITT during INTEX-A
- First look of TES CO and the comparison with AIRS CO
- Data status and plans
- Summary

AIRS CO Measurements

- **AIRS was designed to provide operational Temp, H_2O, O_3 profiles.**
- **AIRS has the capability of measuring certain types of trace gases, such as CO, CH_4, and CO_2, however, still in research mode.**
- **A major advantage for AIRS is the nearly daily global coverage due to both wide swaths and the use of cloud cleared data.**

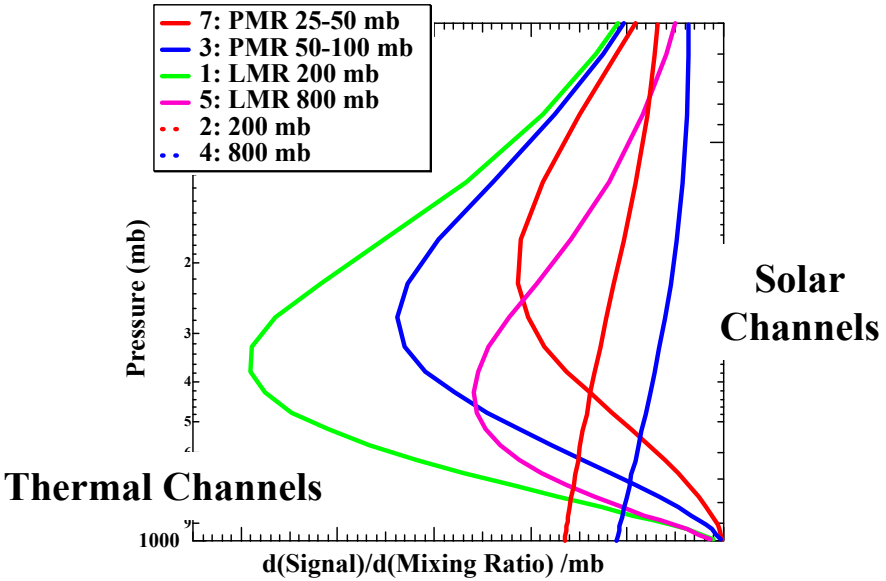


Instrument Sensitivity(ΔT) for 5% CO perturbation (K/km) indicating main sensitivity to mid-tropospheric CO between approximately 300 and 600mb.

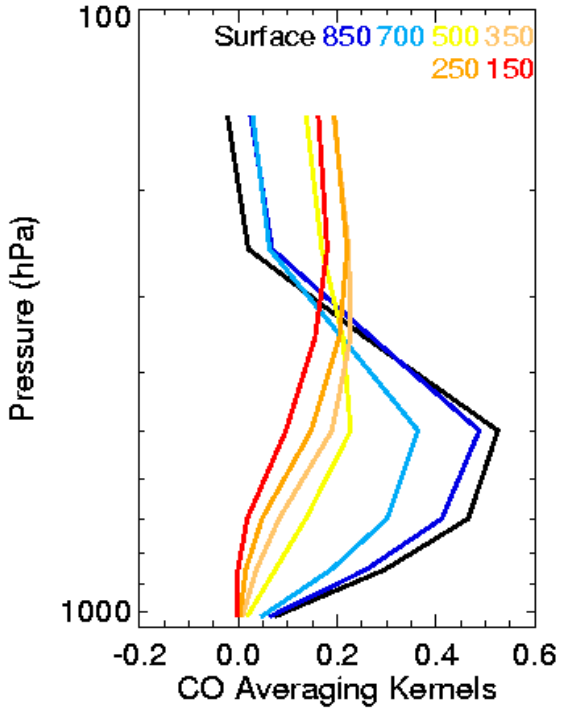


AIRS CO retrieval is based on eigenvector decomposition with damping to converge for solutions, and a set of trapezoidal functions are used as perturbations [Susskind *et al.*, 2003]. Current version of retrieval codes are provided by Barnet from NOAA/NESDIS.

MOPITT CO Difference Channel Weighting Functions

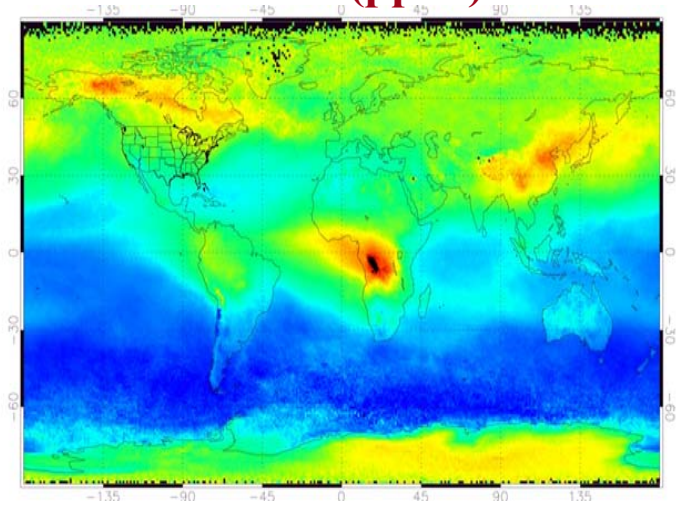


- MOPITT uses correlation radiometry sensing at 4.7µm
- CO thermal channel weighting functions peak in the mid- troposphere
- These are fairly broad and over-lapping
- PMR channels have lower cell pressures and peak higher
- LMR channels have higher pressures and peak lower
- Highest sensitivity at present at 700mb and 300mb



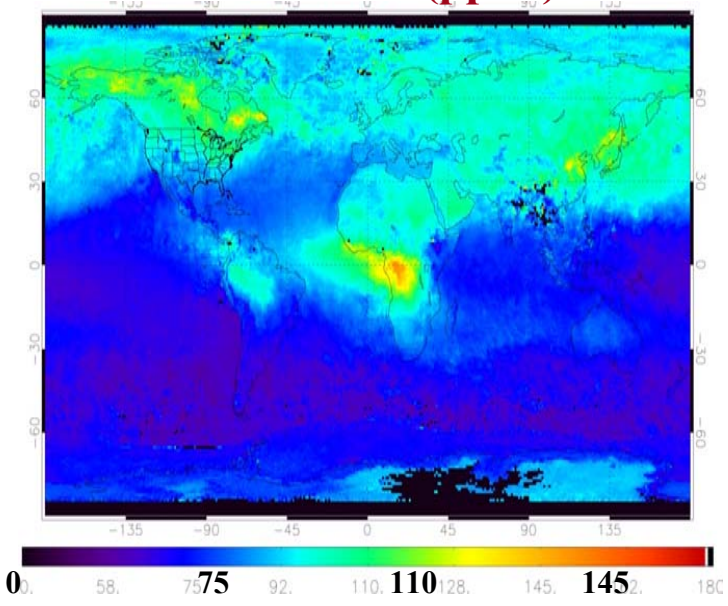
AIRS/MOPITT Direct Comparisons During INTEX-A

AIRS CO VMR (ppbv) at 500mb

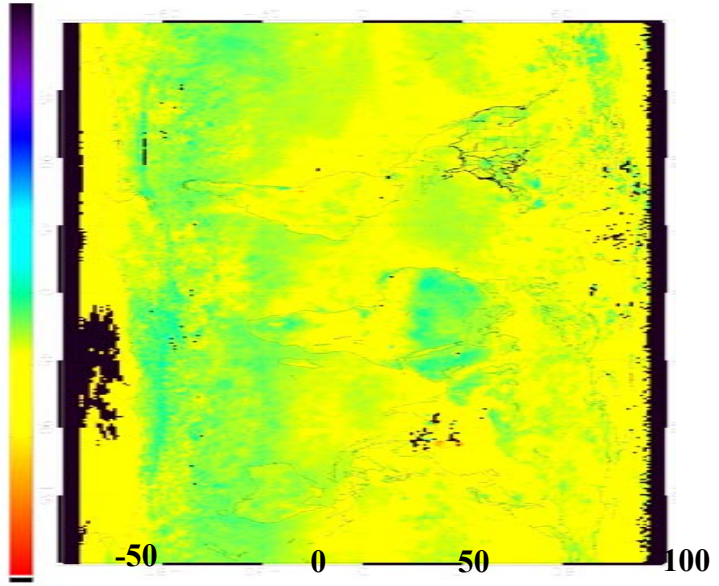


- Gridded at 1x1 degrees and averaged over June 15-Aug. 14, 2004
- AIRS retrievals using pre-launch algorithm with AFGL first guess
- Biases are on the average at 20 ppbv but can be as high as 50 ppbv over source regions and transported plumes.

MOPITT CO VMR (ppbv) at 500mb

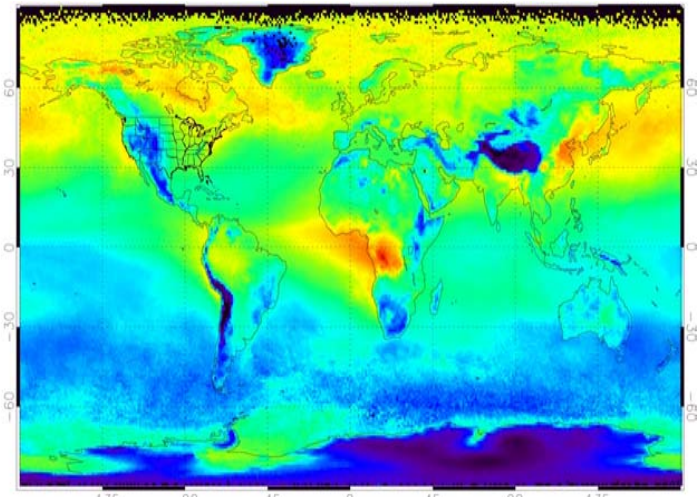


AIRS-MOPITT VMR (ppbv) at 500mb



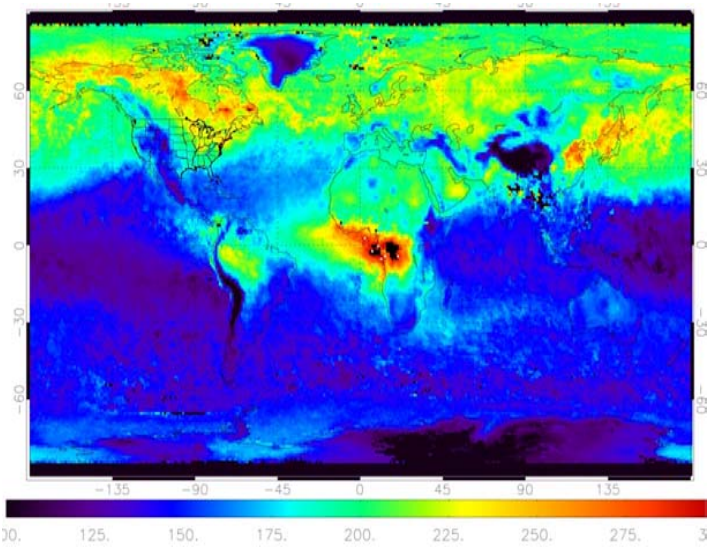
CO Total Column Direct Comparisons

AIRS Total Column CO (Mols/cm^2)

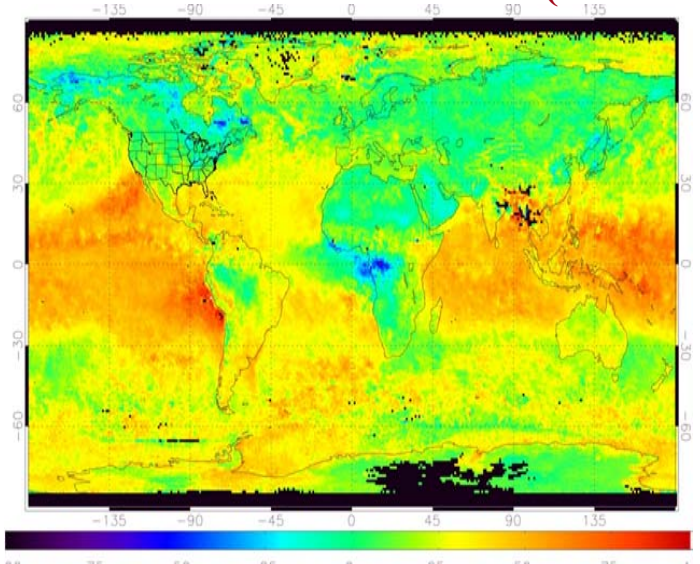


- Same data used as the previous slide
- AIRS CO shows much higher CO over low CO areas in the column
- MOPITT can capture higher CO values in the source regions
- Large differences over the tropical oceans are likely due to AIRS' lack of sensitivities in the lower atmosphere

MOPITT Column CO (Mols/cm^2)

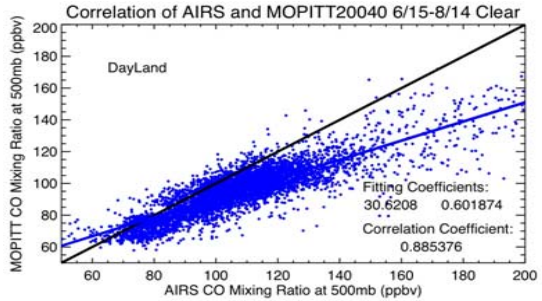


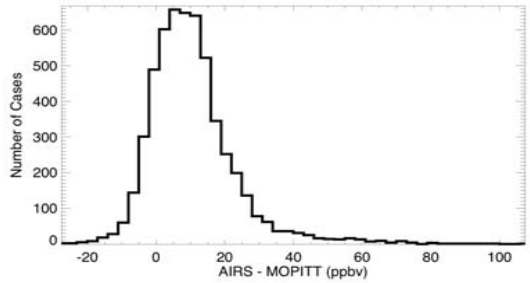
AIRS-MOPITT Column CO (Mols/cm^2)

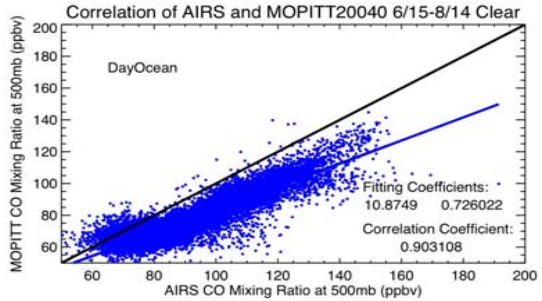


CO VMR at 500mb Direct Comparison Using AFGL First Guess

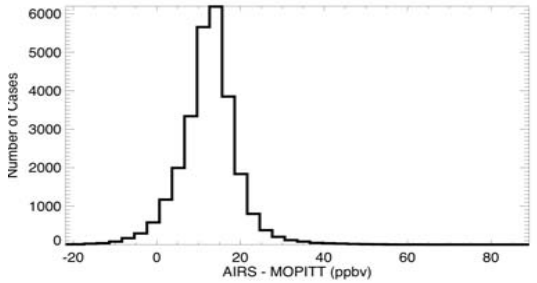
Day Land



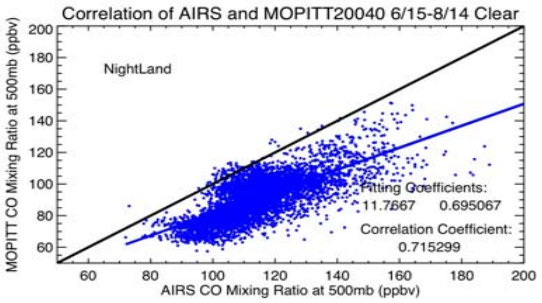


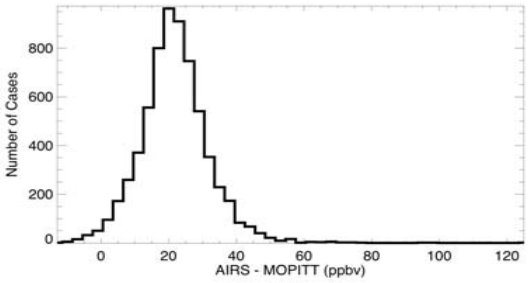


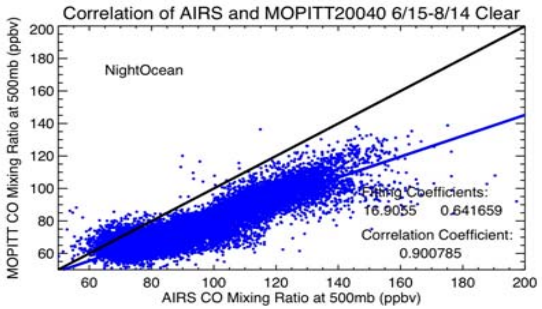
Day Ocean



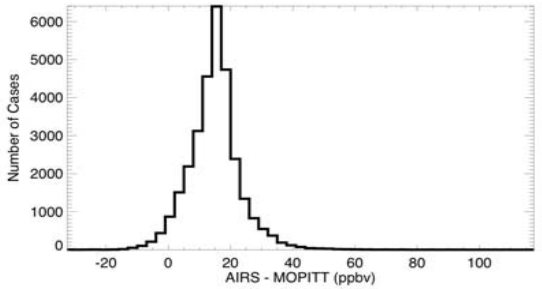
Night Land





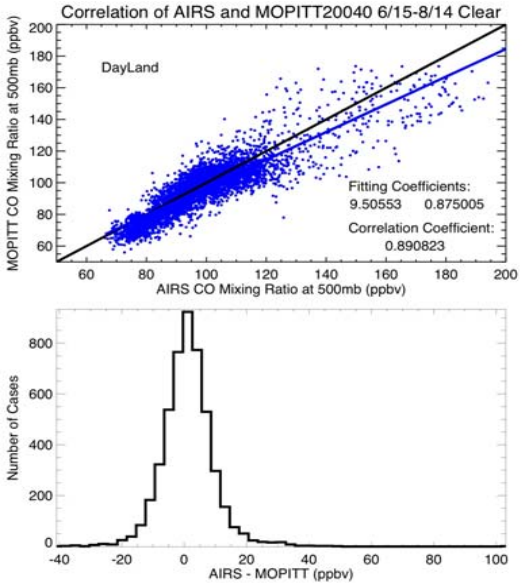


Night Ocean

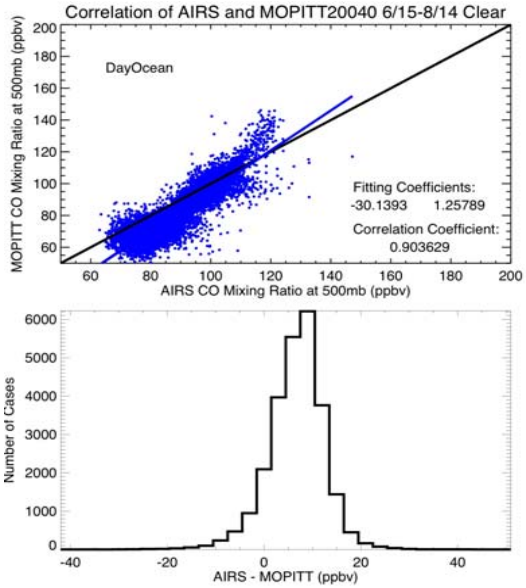


CO VMR at 500mb Comparison Using MOPITT *a priori*

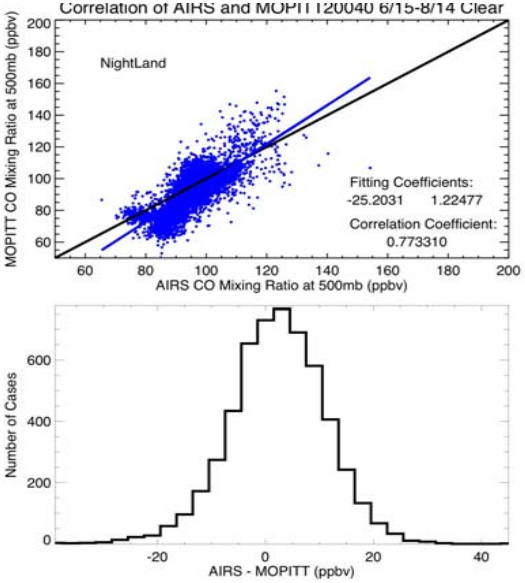
Day Land



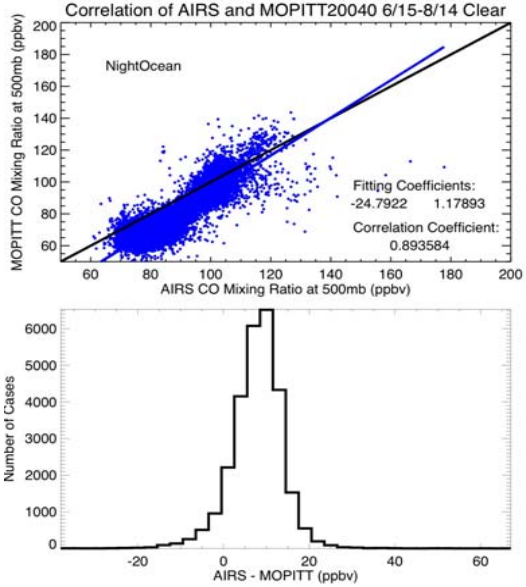
Day Ocean



Night Land

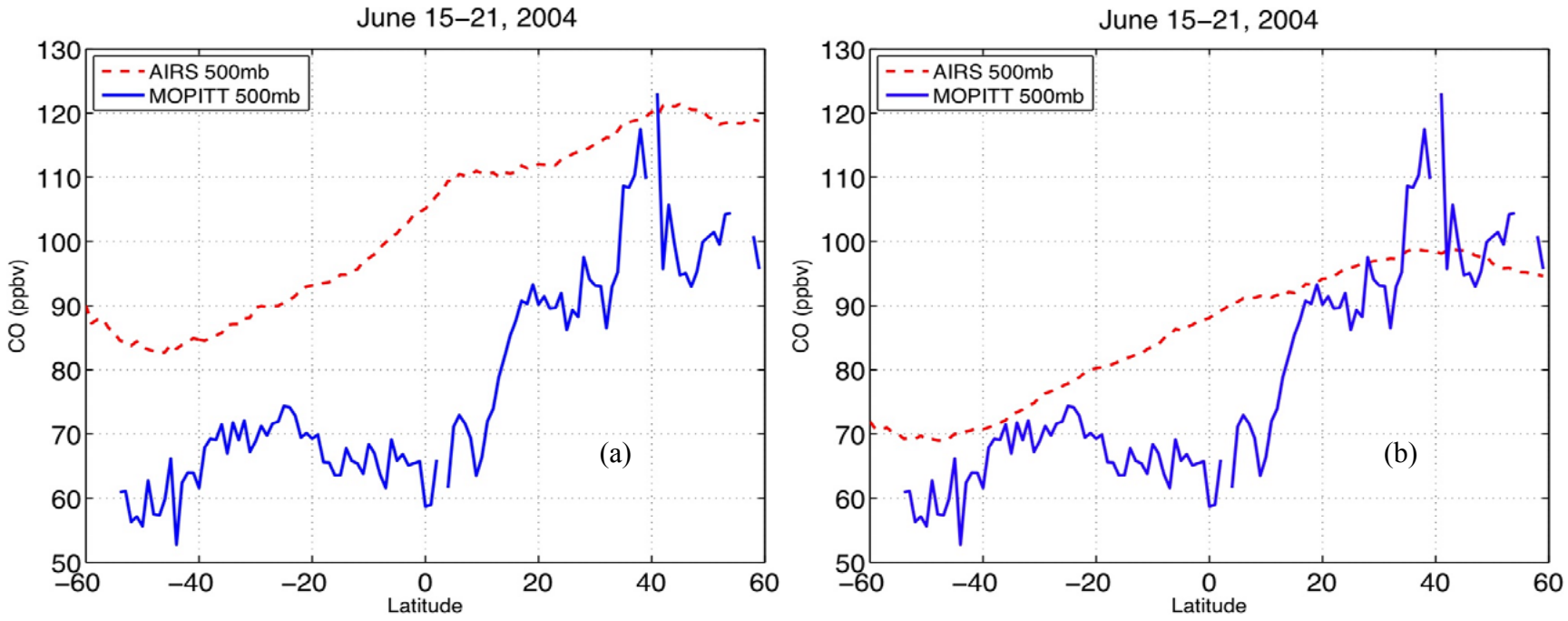


Night Ocean

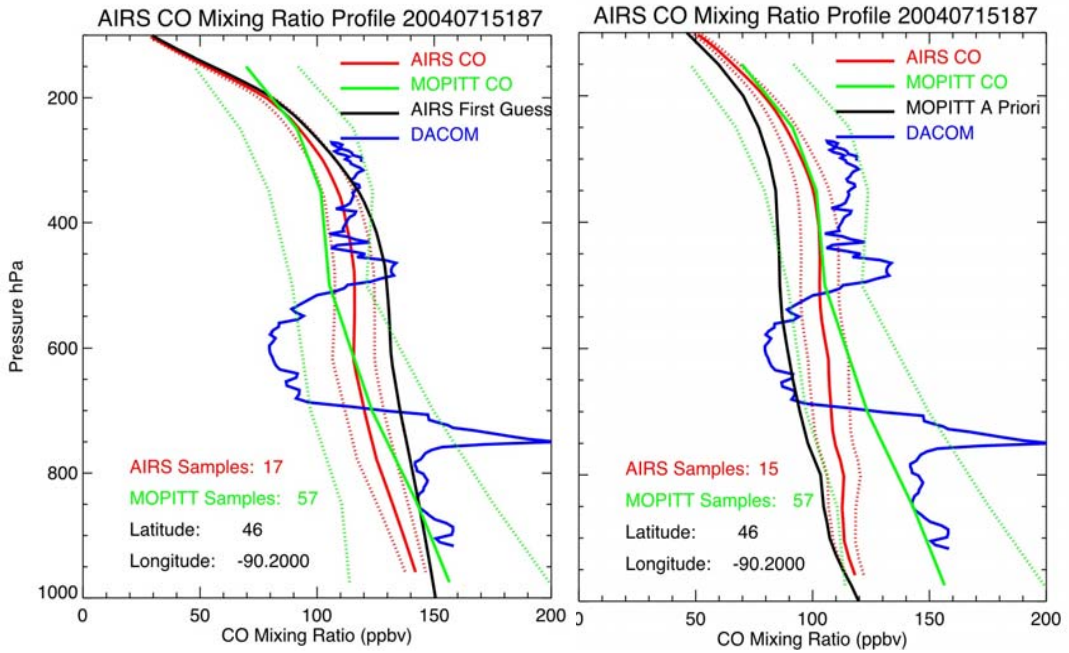


CO vmr at 500mb Zonal Average Comparisons Between AIRS and MOPITT

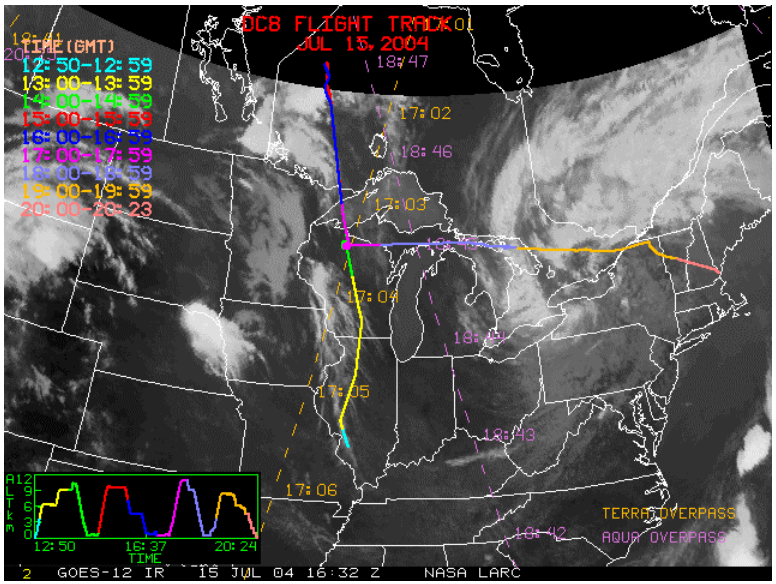
The comparison of zonally averaged CO mixing ratios at 500mb between AIRS (red dashed) and MOPITT (blue solid). (a) shows the comparison when AIRS CO is retrieved using the AFGL 1st guess, and (b) when the MOPITT a priori is used as the 1st guess for AIRS for the week of June 15-21.

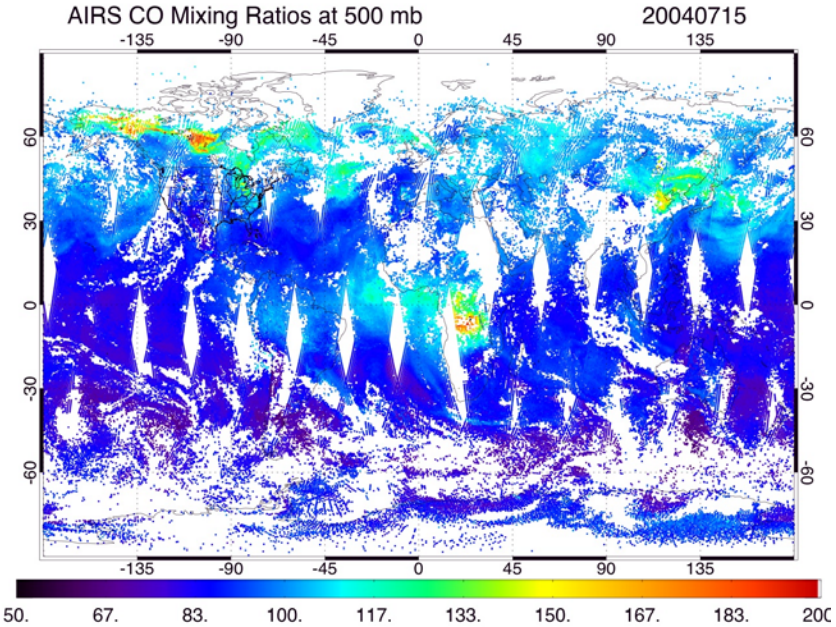


July 15, 2004 During INTEX-A

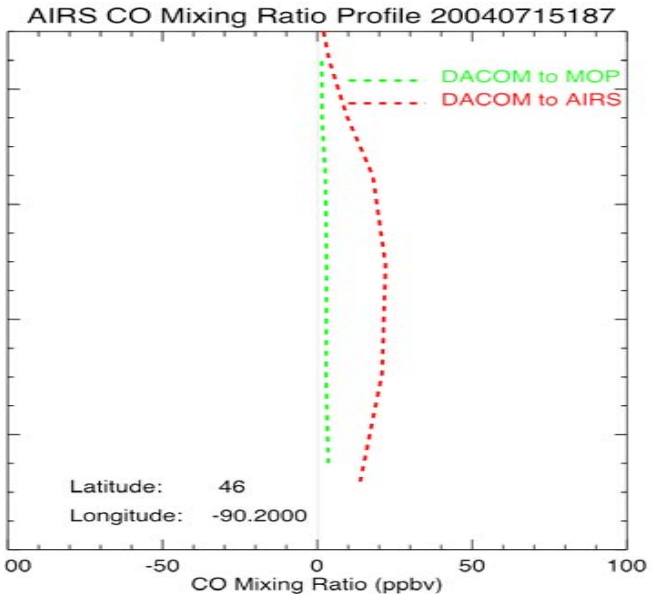


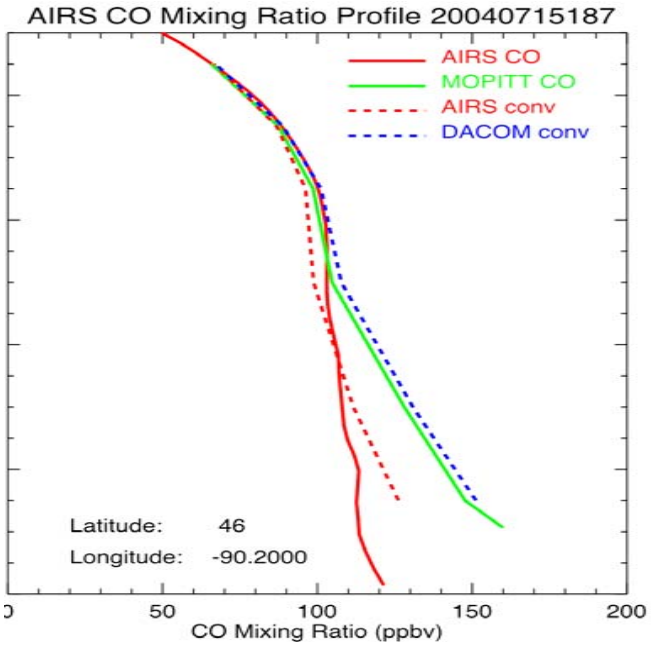
- **Beginning of Alasky and Canadian fire transport**
- **AIRS profiles capture the CO layer between 300 and 600mb well, however show dependencies on the 1st guess**
- **MOPITT capture some low lever high CO showing good sensitivity**
- **MOPITT more cases and higher sdv due to higher spatial resolution**
- **Needs to convolve the *in situ* for better understanding of the measurements**





Comparisons with Convolution





MOPITT AK:

$$x_{ret} = Ax + (I - A)x_a + \varepsilon_x$$

AIRS equivalent Averaging Kernel:

$$x_{ret} = Ax + (I - A)x_a + \varepsilon_x$$

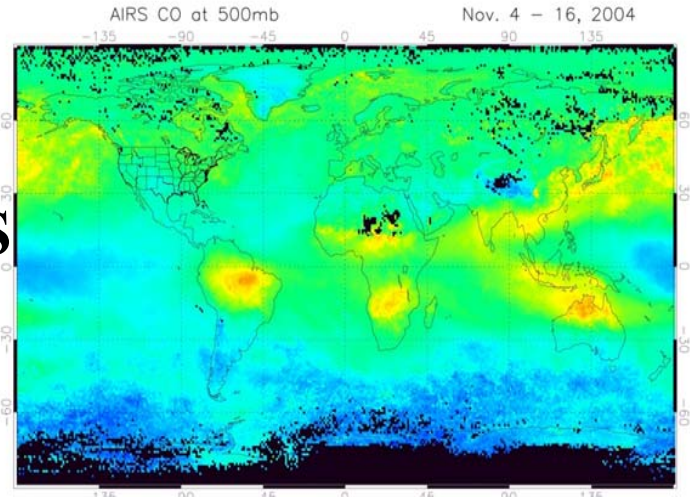
$$A = U\frac{\lambda}{\lambda + \Delta\lambda}U^T$$

- **The differences of the averaged MOPITT and the averaged DACOM convolved to MOPITT (DACOM - MOPITT)**
- **Same above for AIRS**
- **Reasons for AIRS' large values are under investigation**
- **Convolution of the averaged AIRS CO profiles to MOPITT retrievals to minimize the differences due to the first guess/*a priori* influence in the comparison.**

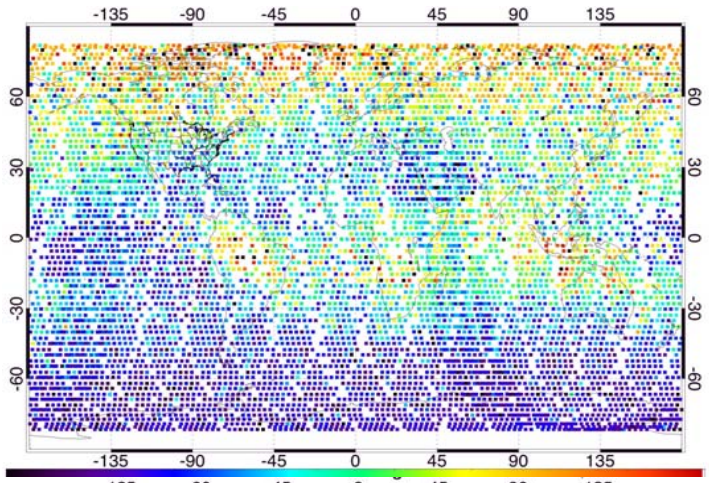
AIRS/MOPITT/TES Nov. 4 - 16, 2004

- This TES dataset is before the TES bench warming in 2005 and no quality control is applied
- All three sensors capture the large features of the elevated CO.
- MOPITT and TES agree more at low CO values over the Southern Hemisphere oceans than with AIRS.
- TES high values at high Northern Hemisphere latitudes seems be artificial.

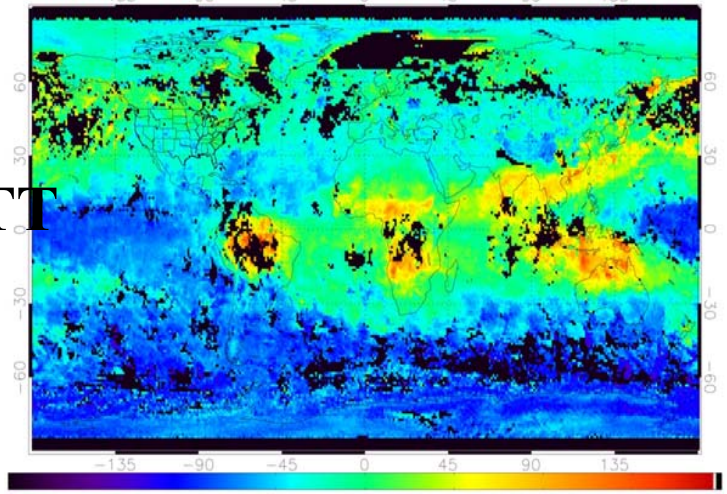
AIRS



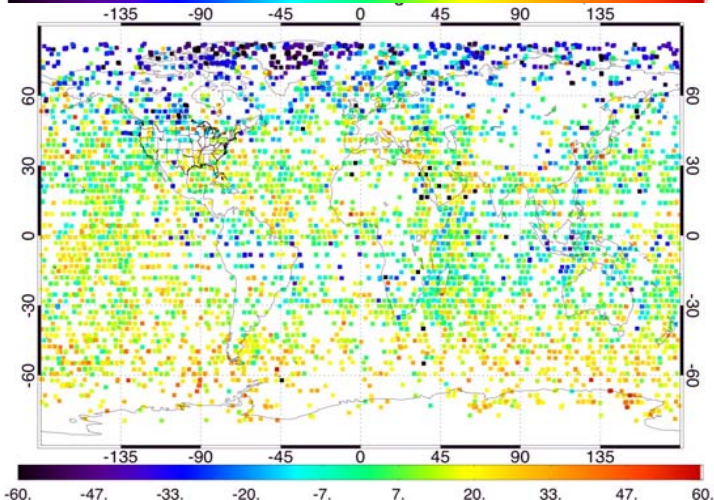
TES



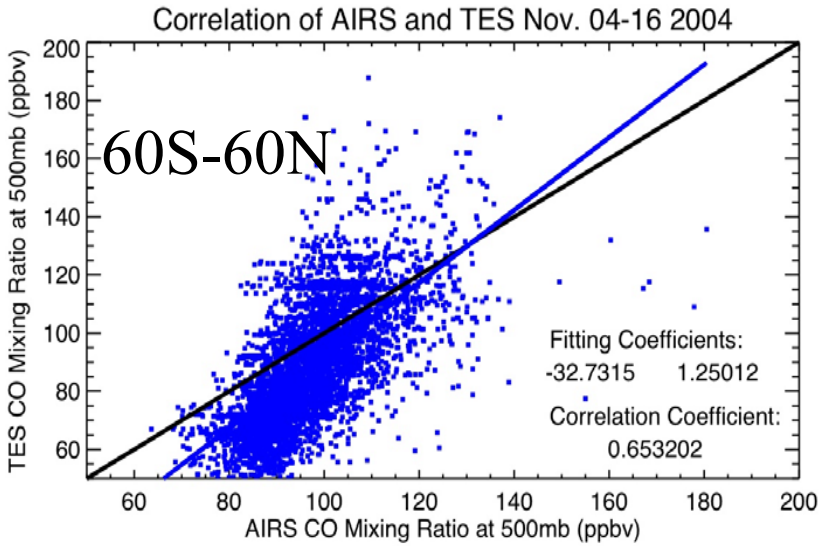
MOPITT

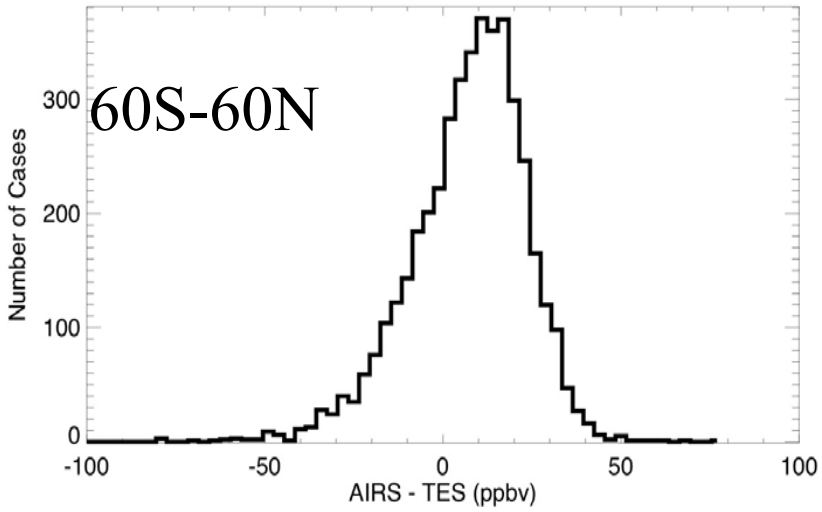


AIRS -TES

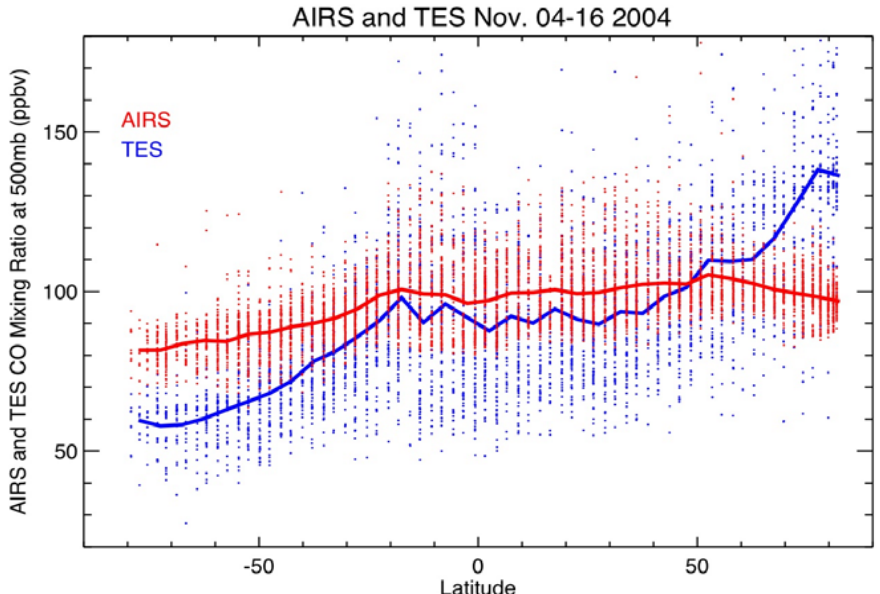


CO vmr at 500mb Zonal Average Comparisons Between AIRS and MOPITT





- AIRS shows higher values over areas with low CO.
- TES shows higher CO over elevated regions of transpored and/or local emission areas compared to AIRS.
- TES CO values and noise are higher north of 60N, which may be explained by the degree-of-freedom.
- Correlation coefficient between AIRS and TES (0.65) are lower than between AIRS and MOPITT (0.73-0.9).
- An average bias of 10-15 ppbv with half width less than 20ppbv.



Data Status and Plans

- **AIRS CO data submission to AVDC in progress that include:**

Four AVEs:

(1) Houston04, Oct29-Nov12, 2004. **ordered and processed** for 20S-80N; 90W-120E
(2) Portsmouth, NH, Jan24-Feb9, 2005. **ordered** 20S-80N; 60W-150E
(3) Houston05, Jun9-Jul7, **ordered**. 20S-80N; 90W-120E
(4) Costa Rica, Jan16-Feb9, **ordered and processed**. 20S-80S; 60W-150E

And two field campaigns:

(1) INTEX-B/MILAGRO: Houston06 March 01-May 15, 2006 20S-80N; 90W-120E
(2) TexAQS: Houston06 March 01-May 15, 2006 20S-80N; 90W-120E

- **Coincident AIRS/TES CO dataset for all TES measurements to be available to collaborators in AURA community**
- **AIRS CO data release through NASA DAAC anticipated in the spring 2007**

Summary

- **TES/AIRS/MOPITT tropospheric CO measurements can all capture the large features of the elevated CO and they generally agree within 20 ppbv at all levels when the same *a priori* is employed.**
- **Future work will include the comparisons using more extended datasets including more spatial and temporal coverage and *in-situ* measurements.**
- **Will continue to provide AIRS CO datasets to AURA community before data release and reprocess through DAAC.**
- **To understand the true observational differences between the sensors, the same retrieval algorithm and with the same *a priori* should be used.**
- **Other factors that affect the quality of the retrievals, such as the cloud interference, should be studied.**